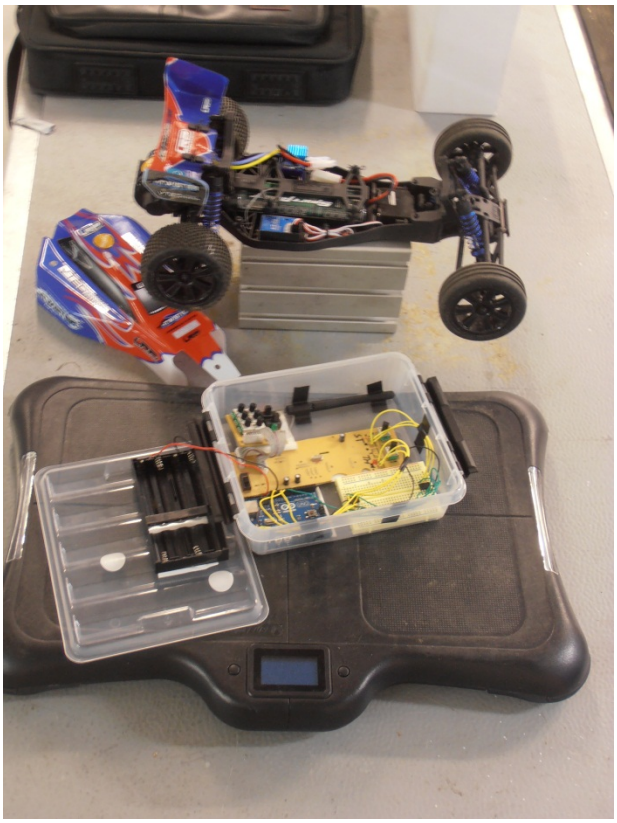
Motion Controlled RC Car



Kon-41.3131 Mechatronics Exercises

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Project Goals:

The goal of our project was to be able to control an RC car with a wii balance board. We wanted the car to go forward when user was leaning forward and also we wanted the car to go backward when the user was leaning backward. And the same procedure with steering right and left. We wanted to have a proportional steering in all four directions.

Procedure:

None of us have had much experience with these kinds of projects; therefore we started the project by gathering information and figuring out what needed to be done. We found out that we needed a computer between the balance board and the RC transmitter. The balance board cannot connect to Arduino directly even if the Arduino would have had a Bluetooth module because neither one of them can operate as a host, they are both additional devices. Bluetooth connection always needs a host so we needed a computer for that. An Arduino microcontroller was needed to be able to control the transmitter and some programming was also needed. We decided to split this project into two pieces. The first task was to have a connection between the balance board and the computer and to be able to read signals received from balance board. The other task was to send those signals through the Arduino to the RC car. A sketch of our project can be seen in figure 1.

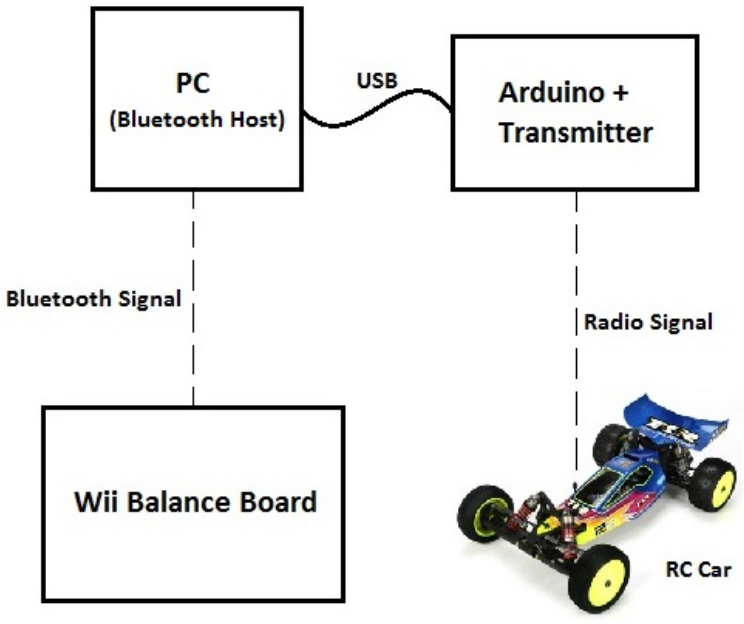


Figure 1

Phase 1: Balance board and computer

We started this phase by gathering more information about how to able to read those signals, sent by balance board, with the computer. We were able to find some projects that had done this by using program called “GlovePie”. To be able to use GlovePie we also needed a program called “BlueSoleil” which is a program that creates a Bluetooth connection to the computer with the device desired. BlueSoleil was needed because the GlovePie was not able to find balance board with the standard Bluetooth connection created by computer. With these two programs we were able to read the x and y values from balance board, but we were not able to send those values to Arduino. For the sending we would have needed a program called “Processing” and for that program a library called “oscP5” which stands for “open sound control”. However, it wasn’t that easy to use this program and we realized that this whole project was getting too complex and heavy so we decided to use our plan B.

We decided to write our own code for reading the signals from balance board. We decided to write this program with Python because we found a good library for Python that was used in a similar project. We also found some examples of similar projects that were made with Python. The library was called “wiiboard simple” and it used another library called “pygame”. The advantages of using these libraries were that they made the Bluetooth connection and also read the data from balance board. So all we needed to do was to write the main program which used these libraries and transformed the data so that it could be sent to Arduino. These programs were written by studying how those two libraries function. We also added a xy-coordinate system to computer so that we were able to see graphically what values the balance board was sending.

Phase 2: Arduino and transmitter

The idea of the project was to use the Arduino controller to take inputs from the PC, and then control the throttle and steering channels on the radio transmitter. The Arduino controller used was an Arduino Uno, connected with a USB cable to the computer. For programming, we used the Arduino software for the PC.

The first step was to disassemble the transmitter and take out the circuit boards, battery box and antenna. The steering and throttle inputs were controlled with 2 analog potentiometers in the transmitter casing, connected to a steering wheel and a trigger for throttle/reverse.

Our first idea was to simply measure the voltage difference over the potentiometers in neutral and both end positions. Next, was to recreate the same voltage range with the Arduino using the Arduino’s pulse width modulation-based AnalogWrite function. However, this did not work. By measuring the voltage difference over the potentiometer with an oscilloscope we found out that the voltage in the transmitter circuit was not constant, but instead a 50 Hz pulse signal. Turning the potentiometers then caused a change in pulse height, so we could conclude that the transmitter was using pulse amplitude modulation. This could not be handled with the Arduino alone.

We found out that the easiest way to get it working was to simulate the actual resistance of the analog potentiometers. This could be done using digital potentiometers, which behaves the same as an analog

potentiometer, but is controlled digitally instead of manually. On the Arduino website we found the Mcp4261 code library, which can be used to control digital potentiometers using SPI (Serial Peripheral Interface). However, it was not compatible with the Arduino's standard "SPI.h" library. After a bit more searching, we found an updated library called "McpDigitalPot.h" (available at https://github.com/teabot/McpDigitalPot) which is compatible with the standard SPI library, so we decided to use this library. For digital pots we chose two MCP4161 10kohm single-channel digital pots, which were easily available and seemed to suit our needs.

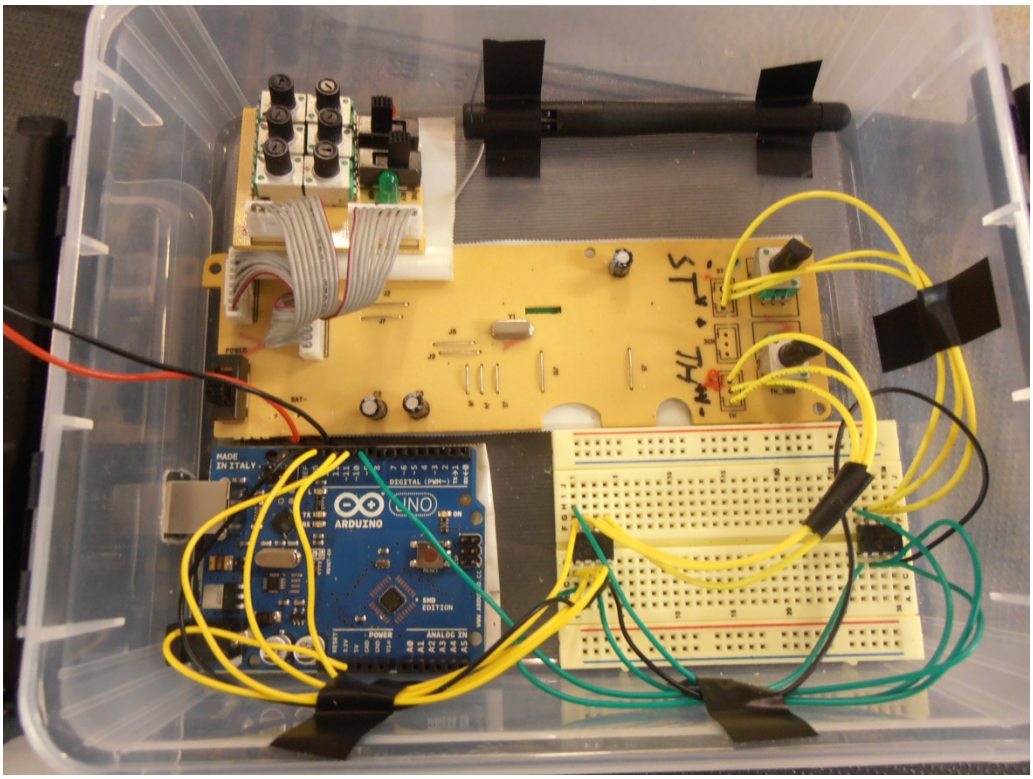
The digital pots were put on a breadboard and connected by wires to the Arduino and the transmitter circuit. The wires were soldered to the holes in the transmitter circuit where the analog pots originally were connected. Unlike dual-channel potentiometers, which have different input and output pins, the MCP4161 have input and output multiplexed onto one pin. We found out that since we will not be reading any data from the pot, we could ignore the output of the potentiometer and only connect the input/output pin on the potentiometer to its input (an output pin on the Arduino).

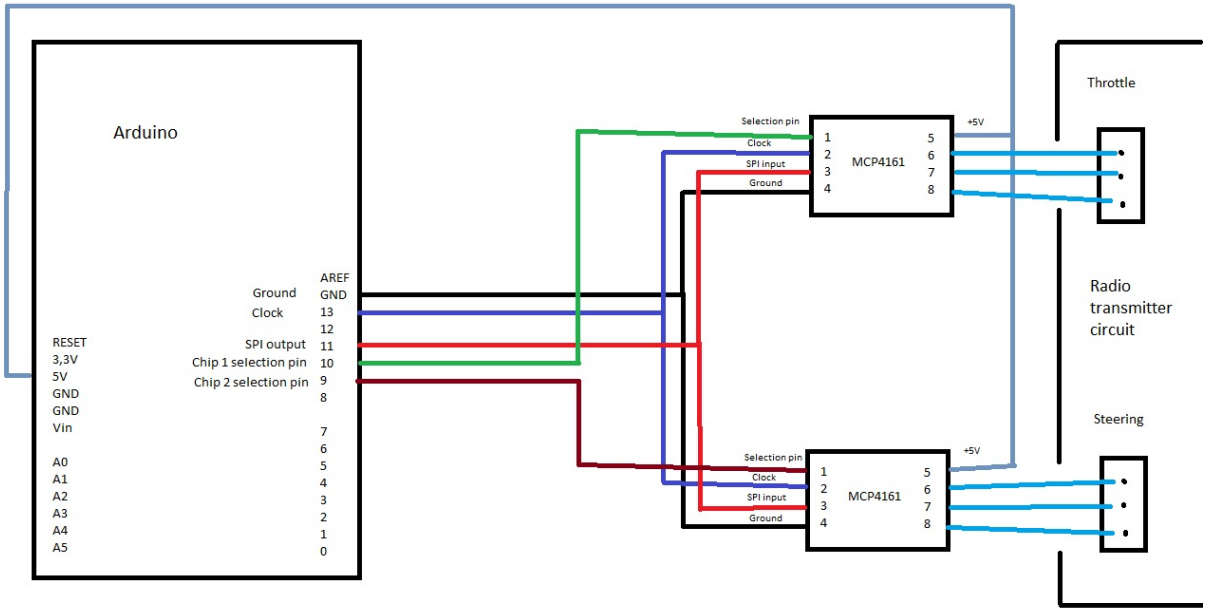
The code for the Arduino works in the following way:

A text string of 4 numbers (weight on every corner of the balance board, in the form "50/20/20/10/"), separated by '/' is sent to the Arduino. The Arduino saves each number as a variable. Then the sums of the weight on the front, rear, left and right halves of the board are calculated.Using the calculated sums, and the sum of all the weight of the board, the displacement of the center of mass on the board is calculated in x- and y-directions. If the displacement is greater than a certain dead zone value, the displacement value is mapped to a resistance value between the neutral value and the end value. Finally, each of the potentiometers is selected in turn, and the resistance value is sent to the currently selected potentiometer. The potentiometers are connected to the same output pin on the Arduino, but only the potentiometer with its selection pin currently set to LOW will receive the input data. After the input data is sent, the potentiometer is unselected.

At first we tried using the same resistance range as the analog potentiometers, but the car did not respond to this. Instead, we had to test different resistance values to get the desired response. The used resistance range ended up much bigger than the range of the analog pots. The reason for this is unclear to us.

It should be noted that the Arduino code is long and ineffective, since our experience in coding was very limited, and parts of the code where quickly put together in the ending phases of the project, when we were making the connection between the Arduino and PC. As we got the whole system working in the ending phase, there was no time for tuning and further development of the program and the control algorithm. There is probably much room for improvements in the code.




Arduino
RESET
3,3V
5V
GND
GND
Vin
A0
A1
A2
A3
A4
A5
Ground
Clock
SPI output
Chip 1 selection pin
Chip 2 selection pin
AREF
GND
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Selection pin
Clock
SPI input
Ground
MCP4161
+5V
Throttle
Radio transmitter circuit
Steering

Final results:

In the end, our results matched up with our goals! After some long hours of programming and getting the arduino microcontroller hooked up with the car controller correctly, the car works. Once all components are turned on the code updated, if a person were to stand perfectly balanced on the board, the car would not move. Leaning forward on the board then allows the car to move forward. In this direction, speed can even be controlled on how far the person leans. When going in reverse, it is a little bit trickier, as there is mostly one speed, but the function still works. Finally, the person can steer the car properly, left or right, simply be shifting his or her weight on the board. In conclusion, we created a functioning RC car controlled by using a balance board.

We tested the system outside and it worked fine, although it was quite hard to be able to drive straight. There are also some problems that occur every once and a while: there is some contact issues with the wiring, the program freezes sometimes and sometimes the car starts going backwards when user is leaning forward and the opposite. However the steering works fine all the time.

Further development:

In further developing our motion controlled RC car, there are several things that can be done. The first thing to consider is taking the current bread board, and making a printed circuit board (PCB). As of now, the bread board has two chips and wires running everywhere between the original controller and the arduino microcontroller. Therefore, two small PCB's could be constructed for the chips with the proper configuration for the wires. Time was tight when it came to getting ready to present for the Mechatronics Circus, so this task never occurred. However, it would not take too much time and the PCB seminar taught earlier in the course would help.

A second task that could be done is to refine our computer code. Both the python and arduino code potentially have minor flaws in them. This is because every once in a while the program will freeze up, particularly when the car would go in reverse suddenly or for an extended period of time. None of the four group members have had substantial work with programming, so consulting a computer engineer or electrical engineer with more experience would help our situation. Also, we could add more code to the programs in order to make the driving of the car more precise. This can always be improved, since it is our first time conducting such a project. Steering could be made sharper and acceleration faster or slower depending on one's weight on the balance board. None the less, the car still operates properly and the overall programming is successful.

To make our project even more sophisticated, we could remove the computer all together. Not having the PC act as a host between the balance board and controller would require much more time and could maybe be carried on in a future project. One way to directly improve our car is to use an expansion shield with the arduino microcontroller. This little component could replace the computer itself and connect the two main components. It would require much more coding with the device in order to make it compatible with the existing code, and the existing code would most likely need to be manipulated as well. Another solution would be to start all over with a bigger microcontroller. Our current microcontroller is quite small and general, as we did not need the more expensive one using a PC. If the controller were bigger, Bluetooth accessible, and could act as a host, the PC host could be replaced and the project would be improved.

User's manual:

1. Connect arduino to computer with USB cord
2. Turn power on in all devices
3. Start eclipse
4. Run the main program
5. Follow instructions on screen

Note: If the program fails after the board has been connected to the PC, you will need to restart the PC.

Attachments:

List of components

Name	Units	Price (€)	Description
LRP S10 Twister Buggy	1	135,00	RC Car
Snakebyte balance board	1	29,90	Balance board
Arduino UNO Atmega 328 SMD	1	23,90	Microcontroller
PC	1	-	Bluetooth host
MCP4161	2	20,00	Digital potentiometer
Logic NX85E Vector	1	36,40	Battery charger
Orion sport power 3300mAh	1	26,90	Extra battery

Arduino code

```
//SPI library for communicating with digital potentiometers through SPI protocol
#include <SPI.h>

// McpDigitalPot library available from https://github.com/dreamcat4/McpDigitalPot

#include <McpDigitalPot.h>

// Then choose any other free pin as the Slave Select (pin 10 if the default but doesnt have to be)

#define MCP_DIGITAL_POT1_SLAVE_SELECT_PIN 10 //arduino  <->  Chip Select          -> CS  (Pin 01 on McpDigitalPot DIP)

#define MCP_DIGITAL_POT2_SLAVE_SELECT_PIN 9 //arduino  <->  Chip Select          -> CS  (Pin 01 on McpDigitalPot DIP)


// Its recommended to measure the rated end-end resistance (terminal A to terminal B)
// Because this can vary by a large margin, up to -+ 20%. And temperature variations.

float rAB_ohms = 9700.00; // 10k Ohm

// Instantiate McpDigitalPot object, with default rW (=117.5 ohm, its typical resistance)

McpDigitalPot digitalPot1 = McpDigitalPot( MCP_DIGITAL_POT1_SLAVE_SELECT_PIN, rAB_ohms );
McpDigitalPot digitalPot2 = McpDigitalPot( MCP_DIGITAL_POT2_SLAVE_SELECT_PIN, rAB_ohms );
```

```
// Instantiate McpDigitalPot object, after measuring the real rW wiper resistance
// McpDigitalPot digitalPot = McpDigitalPot( MCP_DIGITAL_POT_SLAVE_SELECT_PIN, rAB_ohms,
rW_ohms );

//Declaring x- and y-displacement of operator's center of mass on the board, measured in % from center
of board

double xDisplacement = 0;
double yDisplacement = 0;



//Declaring helper variables

double frontWeight;     //Total weight on the front
double rearWeight;      //Total weight on the rear
double leftWeight;      //Total weight on the left
double rightWeight;     //Total weight on the right
double totalWeight;     //Total weight
double FL = 0;          //Weight on the front left
double FR = 0;          //Weight on the front right
double RL = 0;          //Weight on the rear left
double RR = 0;          //Weight on the rear right
double throttle;        //Throttle value
double steering;        //Steering value
double throttleResistance;      //Resistance value for the throttle potentiometer
double steeringResistance;      //Resistance value for the steering potentiometer

char FL_input[4];       //A char table to read front left input as a text string
char FR_input[4];       //A char table to read front right input as a text string
char RL_input[4];       //A char table to read rear left input as a text string
char RR_input[4];       //A char table to read rear right input as a text string

char inChar = -1;       //A char where each input char will be read
byte index1 = 0;//Index for going through the FL input string
byte index2 = 0;//Index for going through the FR input string
byte index3 = 0;//Index for going through the RL input string
byte index4 = 0;//Index for going through the RR input string

//Neutral resistance values for throttle and steering, these will be applied when the user input is zero (or
within the deadzone)

double neutralThrottleResistance = 3500;
double neutralSteeringResistance = 3300;
```

```
void setup()
{

 Serial.begin(9600);

  //Declaring output pins for the slave selection signal

  pinMode(MCP_DIGITAL_POT1_SLAVE_SELECT_PIN, OUTPUT);
  pinMode(MCP_DIGITAL_POT2_SLAVE_SELECT_PIN, OUTPUT);



  //Setting both selection pins HIGH (so they are both unselected at first)

  digitalWrite(MCP_DIGITAL_POT1_SLAVE_SELECT_PIN, HIGH);
  digitalWrite(MCP_DIGITAL_POT2_SLAVE_SELECT_PIN, HIGH);



  // initialize SPI:

  SPI.begin();

  }

void loop()
{

  index1 = 0;
  index2 = 0;
  index3 = 0;
  index4 = 0;

  byte readChar = 1;       //A variable keeping track of which input is currently being read

  while (Serial.available() > 0)
  {

    if (readChar == 1)       //If reading input 1 (FL)

    {

      inChar = Serial.read();           //Read 1 char to inChar
      delay(1);

      if (inChar != '/')         //As long as the input text is not '/', save the input to FL_input, increasing the
index every time
      {
```

```
    FL_input[index1] = inChar;
    index1++;

   }

   else //If input is '/', that is the end of the current input, put end of string to FL_input and start reading the next input by increasing readChar by 1

   {

    FL_input[index1] = '\0';
    readChar++;

   }

  }

  if (readChar == 2)

  {

   inChar = Serial.read();
   delay(1);
   if (inChar != '/')

   {

    FR_input[index2] = inChar;
    index2++;

   }

   else

   {

    FR_input[index2] = '\0';
    readChar++;

   }

  }

  if (readChar == 3)

  {
```

```
  inChar = Serial.read();
  delay(1);
  if (inChar != '/')
  {
    RL_input[index3] = inChar;
    index3++;
  }
  else
  {
    RL_input[index3] = '\0';
    readChar++;
  }
 }
 if (readChar == 4)
 {
  inChar = Serial.read();
  delay(1);
  if (inChar != '/')
  {
    RR_input[index4] = inChar;
    index4++;
  }
  else
  {
    RR_input[index4] = '\0';
    readChar++;
  }
 }
}
```

```
 FL = atoi(FL_input);
 FR = atoi(FR_input);
 RL = atoi(RL_input);
 RR = atoi(RR_input);

 frontWeight = FL + FR;
 rearWeight = RL + RR;
 leftWeight = FL + RL;
 rightWeight = FR + RR;
 totalWeight = FL + FR + RL + RR;

 //THROTTLE

 if (frontWeight > rearWeight)                    //FORWARD

 {

   xDisplacement = (frontWeight/totalWeight - 0.5) * 200;          //Calculates a value of x-displacement between 0 and 100%

   throttleResistance = map(xDisplacement, 10, 100, 6500, 8000);      //Maps throttle input between 10% and 100% to resistance between 6500 ohms and 8000 ohms


   if (xDisplacement > 0)                          //If x-displacement is within 10% deadzone

    throttle = throttleResistance;

   else                                    //If not within deadzone

    throttle = neutralThrottleResistance;

 }

 else                                    //REVERSE

 {

   xDisplacement = (rearWeight/totalWeight - 0.5) * 200;          //Calculates a value of x-displacement between 0 and 100%

   throttleResistance = map(xDisplacement, 5, 100, 2500, 800);      //Maps throttle input between 5% and 100% to resistance between 2500 ohms and 800 ohms
```

```
  if (xDisplacement > 0)                          //If x-displacement is within 5% deadzone
    throttle = throttleResistance;
  else                                            //If not within deadzone
    throttle = neutralThrottleResistance;
 }

 digitalWrite(MCP_DIGITAL_POT1_SLAVE_SELECT_PIN, LOW);          //Sets the throttle selection pin LOW (selects the throttle chip) so it can receive input
 digitalPot1.setResistance(MCP_DIGITAL_POT1_SLAVE_SELECT_PIN, throttle); //Sets the resistance of the digital pot
 digitalWrite(MCP_DIGITAL_POT1_SLAVE_SELECT_PIN, HIGH);         //Sets the throttle selection pin HIGH (unselects the throttle chip)
 //STEERING
 if (leftWeight > rightWeight)                    //If turning left
 {
  yDisplacement = (leftWeight/totalWeight - 0.5) * 200;          //Calculates a value of y-displacement between 0 and 100%
  steeringResistance = map(yDisplacement, 5, 100, 3500, 9000);   //Maps steering input between 5% and 100% to resistance between 3500 ohms and 9000 ohms

  if (yDisplacement < 5)                          //If y-displacement is within 5% deadzone
    steering = neutralSteeringResistance;
  else                                            //If not within deadzone
    steering = steeringResistance;
 }
 else                                             //If turning right
 {
```

```
  yDisplacement = (rightWeight/totalWeight - 0.5) * 200;              //Calculates a value of y-displacement between 0 and 100%

  steeringResistance = map(yDisplacement, 5, 100, 2800, 440);         //Maps steering input between 5% and 100% to resistance between 2800 ohms and 440 ohms


  if (yDisplacement < 5)                                  //If y-displacement is within 5% deadzone

    steering = neutralSteeringResistance;

  else                                                    //If not within deadzone

    steering = steeringResistance;

 }


 digitalWrite(MCP_DIGITAL_POT2_SLAVE_SELECT_PIN, LOW);               //Sets the steering selection pin LOW (selects the throttle chip) so it can receive input

 digitalPot2.setResistance(MCP_DIGITAL_POT2_SLAVE_SELECT_PIN, steering); //Sets the resistance of the digital pot

 digitalWrite(MCP_DIGITAL_POT2_SLAVE_SELECT_PIN, HIGH);              //Sets the throttle selection pin HIGH (unselects the throttle chip)

}
```

Python code

```
import wiiboard
import pygame
import time
import serial

def main():

    print "--BalanceBoard controlled RC-Car--"
    time.sleep(1)

    print "Connecting to Arduino"
    ser = serial.Serial('COM7')
    time.sleep(2)
    print "Connected to Arduino"
    time.sleep(1)
```

```
    print "Connecting to WiiBoard"

    pygame.init()

    board = wiiboard.Wiiboard()
    address = board.discover()
    if address == None:
        pygame.quit()
        exit()
    else:
        print "Found Wiiboard at address " + address
    board.connect(address)
    time.sleep(0.5)
    print "WiiBoard ready (Hold the power button to disconnect)"

    screen = pygame.display.set_mode((500 , 500))

    done = False
    while (not done):

        x = 0
        y = 0

        if board.buttonDown == True:
            print "Power button pressed"
            done = True
        else:
            pass

        event = pygame.event.wait()

        if event.type == wiiboard.WIIBOARD_MASS:
            if (event.mass.totalWeight > 10):

                sensor1 = int(event.mass.topLeft / event.mass.totalWeight * 100)
                sensor2 = int(event.mass.topRight / event.mass.totalWeight * 100)
                sensor3 = int(event.mass.bottomLeft / event.mass.totalWeight * 100)
                sensor4 = int(event.mass.bottomRight / event.mass.totalWeight * 100)

                toArduino = str(sensor1) + '/' + str(sensor2) + '/' + str(sensor3) +
'/' + str(sensor4) + '/'

                ser.write(toArduino)
                time.sleep(0.05)

                x = (sensor1 + sensor3) - (sensor2 + sensor4)
                y = (sensor1 + sensor2) - (sensor3 + sensor4)

            else:
                ser.write('25/25/25/25/')
                time.sleep(0.1)
        else:
            pass

        xScreen = int(x * -2.5 + 250)
```

```
        yScreen = int(y * -2.5 + 250)

        screen.fill((0, 0, 0))
        pygame.draw.line(screen,(255,255,255),(250,0),(250,500))
        pygame.draw.line(screen,(255,255,255),(0,250),(500,250))
        pygame.draw.circle(screen,(255,0,0),(xScreen,yScreen),7)
        pygame.display.flip()

        pygame.event.clear()

    board.disconnect()
    print "WiiBoard disconnected"

    pygame.quit()

main()
```

Modified WiiBoard library

The library found at http://code.google.com/p/wiiboard-simple/ was modified slightly so that it prints out the right instructions.

```
import bluetooth
import sys
import thread
import time
import pygame

base = pygame.USEREVENT
WIIBOARD_BUTTON_PRESS = base + 1
WIIBOARD_BUTTON_RELEASE = base + 2
WIIBOARD_MASS = base + 3
WIIBOARD_CONNECTED = base + 4
WIIBOARD_DISCONNECTED = base + 5


CONTINUOUS_REPORTING = "04" #Easier as string with leading zero

COMMAND_LIGHT = 11
COMMAND_REPORTING = 12
COMMAND_REQUEST_STATUS = 15
COMMAND_REGISTER = 16
COMMAND_READ_REGISTER = 17

#input is Wii device to host
INPUT_STATUS = 20
INPUT_READ_DATA = 21

EXTENSION_8BYTES = 32
#end "hex" values
```

```
BUTTON_DOWN_MASK = 8

TOP_RIGHT = 0
BOTTOM_RIGHT = 1
TOP_LEFT = 2
BOTTOM_LEFT = 3

BLUETOOTH_NAME = "Nintendo RVL-WBC-01"


class BoardEvent:
	def __init__(self, topLeft,topRight,bottomLeft,bottomRight, buttonPressed,
buttonReleased):

		self.topLeft = topLeft
		self.topRight = topRight
		self.bottomLeft = bottomLeft
		self.bottomRight = bottomRight
		self.buttonPressed = buttonPressed
		self.buttonReleased = buttonReleased
		#convenience value
		self.totalWeight = topLeft + topRight + bottomLeft + bottomRight

class Wiiboard:

	# Sockets and status
	receivesocket = None
	controlsocket = None

	def __init__(self):
		self.calibration = []
		self.calibrationRequested = False
		self.LED = False
		self.address = None
		self.buttonDown = False
		for i in xrange(3):
			self.calibration.append([])
			for j in xrange(4):
				self.calibration[i].append(10000) #high dummy value so
events with it don't register

_		self.status = "Disconnected"
_		self.lastEvent = BoardEvent(0,0,0,0,False,False)

		try:
			self.receivesocket = bluetooth.BluetoothSocket(bluetooth.L2CAP)
			self.controlsocket = bluetooth.BluetoothSocket(bluetooth.L2CAP)
		except ValueError:
			raise Exception("Error: Bluetooth not found")

	def isConnected(self):
		if self.status == "Connected":
			return True
		else:
```

```
                return False

        # Connect to the Wiiboard at bluetooth address <address>
        def connect(self, address):
                if address == None:
                        print "Non existant address"
                        return
                self.receivesocket.connect((address, 0x13))
                self.controlsocket.connect((address, 0x11))
                if self.receivesocket and self.controlsocket:
                        print "Connected to Wiiboard at address " + address
                        self.status = "Connected"
                        self.address = address
                        thread.start_new_thread(self.receivethread, ())
                        self.calibrate()
                        useExt = ["00",COMMAND_REGISTER,"04","A4","00","40","00"]
                        self.send(useExt)
                        self.setReportingType()
                        pygame.event.post(pygame.event.Event(WIIBOARD_CONNECTED))
                else:
                        print "Could not connect to Wiiboard at address " + address

        # Disconnect from the Wiiboard
        def disconnect(self):
                if self.status == "Connected":
                        self.status = "Disconnecting"
                        while self.status == "Disconnecting":
                                self.wait(1)
                try:
                        self.receivesocket.close()
                        self.controlsocket.close()
                except:
                        pass

        # Try to discover a Wiiboard
        def discover(self):
                print "Press the sync button"
                address = None
                bluetoothdevices = bluetooth.discover_devices(duration = 6, lookup_names
= True)
                for bluetoothdevice in bluetoothdevices:
                        if bluetoothdevice[1] == BLUETOOTH_NAME:
                                address = bluetoothdevice[0]
                                #print "Found Wiiboard at address " + address
                if address == None:
                        print "No Wiiboards discovered."
                return address

        def createBoardEvent(self, bytes):
                buttonBytes = bytes[0:2]
                bytes = bytes[2:12]
                buttonPressed = False
                buttonReleased = False
```

```
            state = (int(buttonBytes[0].encode("hex"),16) << 8 ) |
int(buttonBytes[1].encode("hex"),16)
            if state == BUTTON_DOWN_MASK:
                  buttonPressed = True
                  if not self.buttonDown:

      pygame.event.post(pygame.event.Event(WIIBOARD_BUTTON_PRESS))
                        self.buttonDown = True

            if buttonPressed == False:
                  if self.lastEvent.buttonPressed == True:
                        buttonReleased = True
                        self.buttonDown = False

      pygame.event.post(pygame.event.Event(WIIBOARD_BUTTON_RELEASE))

            rawTR = (int(bytes[0].encode("hex"),16) << 8 ) +
int(bytes[1].encode("hex"),16)
            rawBR = (int(bytes[2].encode("hex"),16) << 8 ) +
int(bytes[3].encode("hex"),16)
            rawTL = (int(bytes[4].encode("hex"),16) << 8 ) +
int(bytes[5].encode("hex"),16)
            rawBL = (int(bytes[6].encode("hex"),16) << 8 ) +
int(bytes[7].encode("hex"),16)

            topLeft = self.calcMass(rawTL, TOP_LEFT)
            topRight = self.calcMass(rawTR, TOP_RIGHT)
            bottomLeft = self.calcMass(rawBL, BOTTOM_LEFT)
            bottomRight = self.calcMass(rawBR, BOTTOM_RIGHT)
            boardEvent =
BoardEvent(topLeft,topRight,bottomLeft,bottomRight,buttonPressed,buttonReleased)
            return boardEvent


      def calcMass(self, raw, pos):
            val = 0.0
            #calibration[0] is calibration values for 0kg
            #calibration[1] is calibration values for 17kg
            #calibration[2] is calibration values for 34kg
            if raw < self.calibration[0][pos]:
                  return val
            elif raw < self.calibration[1][pos]:
                  val = 17 * ((raw - self.calibration[0][pos]) /
float((self.calibration[1][pos] - self.calibration[0][pos])))
            elif raw > self.calibration[1][pos]:
                  val = 17 + 17 * ((raw - self.calibration[1][pos]) /
float((self.calibration[2][pos] - self.calibration[1][pos])))

            return val

      def getEvent(self):
            return self.lastEvent

      def getLED(self):
            return self.LED
```

```
	# Thread that listens for incoming data
	def receivethread(self):
		#try:
		#	self.receivesocket.settimeout(0.1)		#not for windows?
		while self.status == "Connected":
			if True:
				data = self.receivesocket.recv(25)
				intype = int( data.encode("hex")[2:4] )
				if intype == INPUT_STATUS:
				#TODO: Status input received. It just tells us battery
life really
					self.setReportingType()
				elif intype == INPUT_READ_DATA:
					if self.calibrationRequested == True:
						packetLength =
(int(str(data[4]).encode("hex"),16)/16 + 1)

	self.parseCalibrationResponse(data[7:(7+packetLength)])

						if packetLength < 16:
							self.calibrationRequested = False

				elif intype == EXTENSION_8BYTES:
					self.lastEvent = self.createBoardEvent(data[2:12])
					try:

	pygame.event.post(pygame.event.Event(WIIBOARD_MASS, mass=self.lastEvent))
					except:
						self.disconnect()

				else:
					pass

		self.status = "Disconnected"
		self.disconnect()
		pygame.event.post(pygame.event.Event(WIIBOARD_DISCONNECTED))

	def parseCalibrationResponse(self, bytes):
		index = 0
		if len(bytes) == 16:
			for i in xrange(2):
				for j in xrange(4):
					self.calibration[i][j] =
(int(bytes[index].encode("hex"),16) << 8 ) + int(bytes[index+1].encode("hex"),16)
					index += 2
		elif len(bytes) < 16:
			for i in xrange(4):
				self.calibration[2][i] =
(int(bytes[index].encode("hex"),16) << 8 ) + int(bytes[index+1].encode("hex"),16)
				index += 2

	# Send <data> to the Wiiboard
	# <data> should be an array of strings, each string representing a single hex
byte
```

```
	def send(self,data):
		if self.status != "Connected":
			return
		data[0] = "52"

		senddata = ""
		for byte in data:
			byte = str(byte)
			senddata += byte.decode("hex")

		self.controlsocket.send(senddata)

	#Turns the power button LED on if light is True, off if False
	#The board must be connected in order to set the light
	def setLight(self, light):
		val = "00"
		if light == True:
			val = "10"

		message = ["00", COMMAND_LIGHT, val]
		self.send(message)
		self.LED = light

	def calibrate(self):
		message = ["00", COMMAND_READ_REGISTER ,"04", "A4", "00", "24", "00",
"18"]
		self.send(message)
		self.calibrationRequested = True

	def setReportingType(self):
		bytearr = ["00", COMMAND_REPORTING, CONTINUOUS_REPORTING,
EXTENSION_8BYTES]
		self.send(bytearr)

	# Wait <millis> milliseconds
	def wait(self,millis):
		time.sleep(millis / 1000.0)
```